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# Liquid Manure Management

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## Quick Facts...

- Liquid manure is any manure to which water is added in the collection, storage or treatment processes.
- The word "lagoon" frequently is used to describe a pit in the ground where liquid manure is stored. True lagoons treat manure through bacterial biodegradation.
- Seepage from waste treatment and storage structures is required by Colorado law to be less than 1/32 inch per day.
- Regularly scheduled inspections and prompt repairs will ensure that system components remain functional for a long time.

Liquid manure is any manure to which water is added in the collection, storage or treatment processes. Handling liquid manure has advantages and disadvantages compared to solid manure handling. Liquid manure requires less daily attention, because it is easier to automate the collection process, and involves less labor. However, liquid manure has a higher volume than solid manure, and initial equipment costs are usually higher due to automation.

The word "lagoon" frequently is used to describe a pit in the ground where liquid manure is stored. Technically, lagoons are earthen structures designed to treat manure through biodegradation by bacteria. Properly functioning lagoons reduce both the solid and nitrogen content of liquid manure, control odors and kill pathogens. Lagoons also tend to have additional dilution water added to the manure and longer periods of storage than storage structures. If liquid manure is only stored (not treated), the structure should be called a storage structure, pond or tank.

## Collection From Housing Units

Liquid manure collection from hog housing units usually involves an underslat flushing system and a lagoon-house recycling system. The underslat flushing system consists of a shallow underflooring catching structure (gutter) that is periodically flushed or drained. In addition, other collection systems can be designed for managing and collecting liquid

manure from hog confinement units, such as slatted floors to pit, mechanical scrapers to pit, flush to open gutters, and slatted floors to mechanical scrapers to pits. The choice of collection system depends on the size of the operation, odor and runoff control measures, and the design for manure storage, treatment and use.

Flushing systems in hog units usually operate by pumping water into a flushing tank at the high end of the gutter. Flushed water and manure enter the first lagoon (in the case of a two-stage lagoon), which flows via gravity into the second lagoon. There, the liquid can be recycled for flushing the underslat gutter.

In most dairies, a combination of solid and liquid manure management are used. Normally, the manure from the housing and feeding areas is handled in solid form, and the milking parlor waste is collected with water for easier cleaning and better sanitation. Manure collection from milking parlors usually is done with a flush system. Water can be released from a flushing tank and is often added to the system through sprinklers used to clean cows. The liquid manure storage structures should be large enough to accommodate the runoff from the cow lots as well as the liquid manure from the dairy parlor.

## Decisions to Make Prior to Construction

The decision to build a lagoon or a storage structure should be based on your objectives. Storage structures allow flexibility for land application at optimum times, preserve nutrients, prevent surface and groundwater contamination, and increase efficiency and convenience.

Treatment lagoons improve handling characteristics, reduce manure volume and solid content, control odor, reduce pollution potential by removing nutrients, kill pathogens, and reduce organic matter content. Lagoons meet both storage and treatment objectives in one structure.

### Do I need a liner and what types are available?

Seepage from waste treatment and storage structures is required by Colorado law (Confined Animal Feeding Operations Control Regulation 4.8.0 -- 5 CCR 1002-19) to be less than 1/32 inch per day. If a storage structure holds runoff only, seepage must be less than 1/4 inch per day. Solids and bacteria on the lagoon bottom will clog pores and reduce seepage, but self-sealing action generally cannot be relied on to protect groundwater.

Locate lagoons in the most impervious soil available.The required seepage rate can be achieved four ways:

1. **Compaction.** Compact fine-grained soils (silts and clays) to a minimum 12-inch thickness, with an additional 18 to 30 inches of protective soil cover above the compacted soil.
2. **Bentonite.** Import clay to reduce the permeability of coarse-grained soils (sands and gravels) prior to compaction, with an additional 18 to 30 inches of protective soil cover.
3. **Synthetics.** Install synthetic impermeable liners with 12 to 18 inches soil cover above the liner.
4. **Concrete.** Construct concrete pavement with steel reinforcement and leakproof

joints over a sand bedding.

Avoid siting a lagoon in an area with a high water table (within 2 feet of the lagoon bottom) or in an area where the bottom of the lagoon is in sand or gravels or within 10 feet of fractured, porous limestone.

## Is one lagoon enough for my operation or do I need a secondary lagoon (or more)?

Second-stage lagoons are used for storing liquid manure and for settling solids prior to recycling liquid to the operation. Therefore, the secondary lagoon provides flexibility in storing and applying lagoon liquid. The liquid entering a second-stage lagoon usually is less concentrated than the first-stage, because it has been biodegraded and most solids have settled out in the primary lagoon. Liquid from the second-stage lagoon can be recycled as flush water or pit recharge liquid for confinement facilities.

Advantages of secondary lagoons include less floating debris (less clogging of recycle and irrigation lines) and flexibility in maintaining the minimum volume in the primary lagoon, which minimizes odors and maintains the necessary bacterial concentration for manure treatment. A secondary lagoon increases construction costs and requires greater surface area. The benefits of secondary lagoons depend on rainfall, frequency of irrigation with lagoon liquid, whether lagoon liquid is recycled as flush water or pit recharge liquid, and whether lot runoff is handled separately in the secondary lagoon or combined with the primary waste stream.

## Should I recycle wastewater back through the confinement area or use fresh water to flush the manure collection system?

Recycling lagoon liquid reduces the amount of water added to the system (water requirement) and decreases the quantity of lagoon liquid that must be land-applied. Recycling liquid from a second stage lagoon rather than the primary lagoon reduces the amount of clogging of intake lines. Crystals may build up in recycle lines, but this problem can be minimized through proper material selection and maintenance, such as use of smooth-wall plastic pipe, few elbows and joints, and flow velocities below 5 feet per second.

However, there are also hazards of recycling wastewater, particularly in dairies. The recycled manure makes floors slick, it may cause cows to fall, and the odor is quite strong during recycling. In addition, recycling wastewater should be done with regard for prevailing wind direction, proximity of housing developments and the time of day in order to minimize odor.

## Should I use an anaerobic or aerobic lagoon?

Most lagoons in Colorado are anaerobic (low oxygen levels). Mechanical aerators can be used to add oxygen to a lagoon and make it aerobic. Large shallow lagoons can become aerobic through gas exchange at the surface.

**Anaerobic lagoons.** Advantages: low cost, low labor, and reuse for irrigation or recycling. Disadvantages: high land requirement, odor potential.

**Mechanically aerated lagoons.** Advantages: reduced odor, and less land requirement. Disadvantages: higher energy cost, and high maintenance cost.

### Will separating solids be beneficial to me?

Manure solids can be removed using two predominant methods: settling or screening. Separation of solids offers both advantages and disadvantages:

**Advantages.** Reduced odor; solids can be refed, spread on land or used as bedding (after one full year of aging); reduced lagoon loading (lagoon size requirement is less); liquid with low solid content is easier to handle.

**Disadvantages.** Additional equipment cost, maintenance and management requirements, additional need for storage and handling of solids.

### What about composting?

Composting is an option for operations that separate solids and can result in a marketable product.

**Advantages.** Dry-end product that is easily handled, reduced manure volume, excellent marketable soil conditioner, reduced risk of pollution, reduced pathogens/weed seeds, and reduced odor.

**Disadvantages.** Time, money, energy, land and machinery requirements; ammonia lost to volatilization; possible odor during composting.

## Odor Control

Odor can be controlled throughout the process of siting a dairy or hog confinement facility, design and construction of the facility, operation, and disposal of liquid manure. When choosing a site, consider distance from neighbors (1 mile minimum), wind direction (downwind from neighbors), land base for manure disposal, good soil drainage, and visibility. Elements of design that can reduce odors include:

1. Frequent flushing or scraping.
2. Solid separation; keep solid stockpiles dry and preferably covered or compost them.
3. Lagoon type; aerobic lagoons produce less odor than anaerobic lagoons.
4. Lagoon covers.
5. Windbreaks to reduce airflow across lagoons.

Proper maintenance of the facility inside and out will also keep odors under control. Applying manure when the wind is calm and incorporating the manure as soon as possible will also reduce odors.

## Maintenance

Regularly scheduled inspections, followed by prompt repairs, will ensure that the components of liquid waste management systems remain functional over a long time.

**Berms and slopes.** Maintain vegetated slopes by mowing, controlling weeds, and preventing woody brush or trees. Use gravel or another mulch to protect slopes when dense vegetation cannot be established. Repair immediately any damage to a berm caused by foot or equipment traffic. Keep livestock off the berm to prevent damage and for safety reasons. Look for uneven or excessive settlement, bulges or sink holes, which are signs of structural problems that can result in catastrophic failure. Prevent rodents from burrowing into embankments, and fill existing rodent holes with compacted soil. Quick drawdown of the pond or lagoon level may cause erosion or collapse of the inside slope. Repair it before the level is allowed to rise again.

**Liners.** When the structure is full, look for seepage on the outside of embankments or in areas below the toeslopes. Flowing seeps indicate a liner failure. Seepage that contains soil particles indicates internal erosion that may precede structural failure of the berm and require immediate action. Maintaining the original thickness of protective soil covers over liners helps prevent damage. Avoid damaging the liner or soil cover when agitating and pumping liquids or excavating sludge. Repair drying cracks and other damage to clay liners by excavating the affected area and recompacting it in accordance with the original construction specifications.

**Inlet and outlet structures.** Regularly inspect pipes, valves, channels and related structures. Operate valves on regular intervals to ensure they open and close properly. Inspections should identify signs of corrosion or other structural and material defects that need repair or replacement. Promptly repair erosion in channels or around inlet and outlet structures.

**Tanks.** Inspect tanks for leaks, signs of corrosion, and structural and material defects. Make repairs in accordance with the manufacturer's recommendations. Safety equipment. Regularly inspect fencing, guard rails, wheel stops and other safety devices and correct any problems noted. Make sure that warning signs are visible and readable. Keep rescue equipment, such as ropes, poles, etc., in good condition and close to the pond or lagoon.

## Operational Requirements

### Waste Storage Ponds

There are basically two operating principles: 1) maintain enough volume in the pond at the beginning of extended storage periods (when waste cannot be land applied) to store the waste generated during these periods, and 2) maintain additional volume and freeboard to prevent overtopping caused by direct precipitation and storm runoff from a 25-year rainfall event (see Figure 1). The 25-year storm refers to a rainfall amount with odds of 1 in 25 (4 percent) that it will be exceeded by any actual daily rainfall amount. This value varies from 2 to 6 inches in Colorado, depending on location.

Manure storage ponds are designed to be emptied at least once a year. Thoroughly agitate the pond prior to pumping to stir up the solids that settle to the bottom. Agitation releases strong odors. Plan agitation for times that are least offensive to neighbors. Sample the waste in the pond and test it to determine the nutrient content of the waste prior to cleanout. There will always be some solids that cannot be pumped from the pond as a liquid or slurry. Remove these solids when they accumulate to a depth of 6 to 8 inches over the bottom of the pond. Most ponds can be designed with ramps and paved bottoms

- to facilitate removing solids with conventional farm equipment.

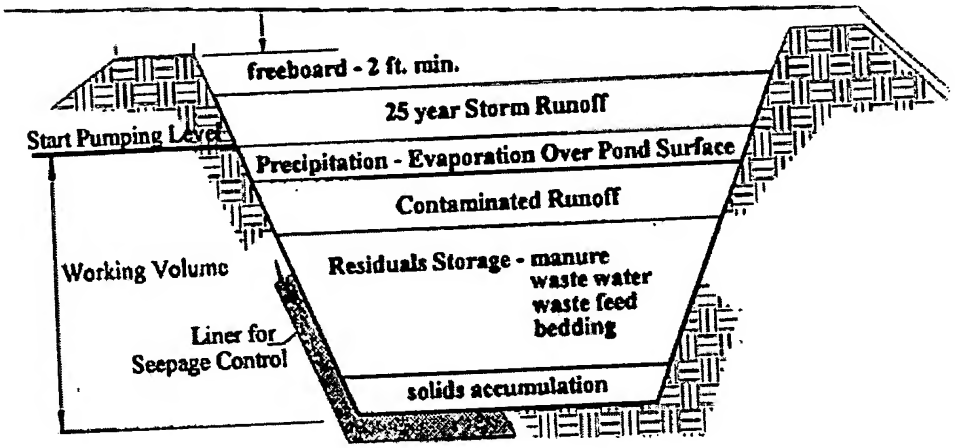


Figure 1: Waste storage pond.

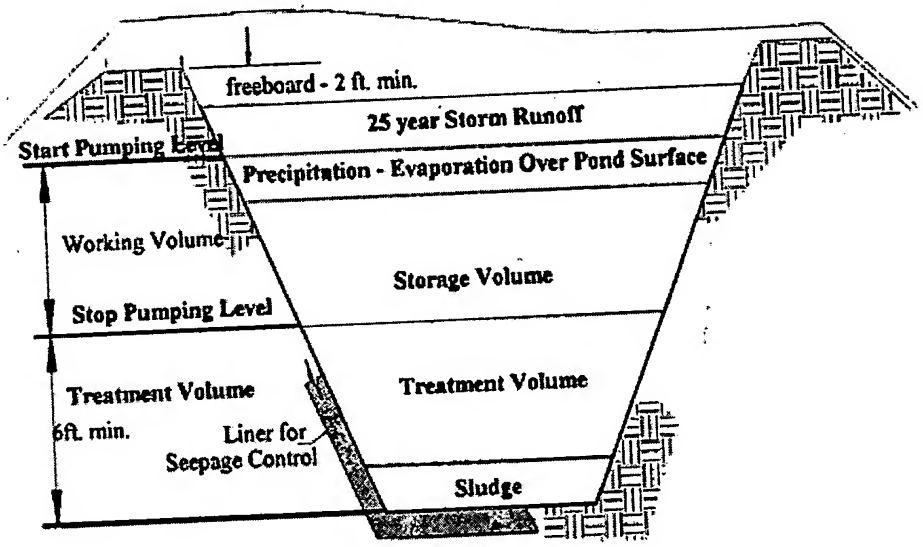


Figure 2: Waste treatment lagoon.

Place staff gauges or other markers to indicate the top of the normal storage level in the pond (working volume). The pond must be drawn down below the normal storage level within 15 days after a rain event. Ponds storing only rainfall runoff from livestock feeding areas will be dry during much of the year. They can be designed to be emptied entirely by evaporation or by a combination of evaporation and pumping.

## Waste Treatment Lagoons

Lagoons typically are designed to provide storage and treatment of waste. Therefore, lagoons have operating requirements to achieve the treatment goals in addition to those

discussed above for storage structures.

The lower level of the lagoon can be described as the "Treatment Volume" (see Figure 2). Biological reactions in the treatment volume are sensitive to changes in the loading rate, temperature and pH. Operation requirements consist of maintaining the proper liquid levels and pH, and ensuring that the maximum loading rates are not exceeded. At inital startup, fill the treatment volume at least half way prior to adding any concentrated manure. Subsequently, the level of waste in the lagoon should be at or above the top of the the treatment volume. You may need to add fresh water to maintain the treatment volume if evaporation losses exceed the waste inflow rate.

Maintain the lagoon pH above 6.5. If the pH falls below 6.5, add a pound of lye or hydrated lime per 1,000 square feet of surface area per day until pH rises above 7.0. Inexpensive pH test kits are readily available from pool supply stores. Lagoon sludge does not need to be removed until the sludge volume occupies about 50 percent of the original treatment volume, which occurs at five- to 10-year intervals. Sludge contains nutrients and should be applied to cropland to take advantage of its fertilizer value. However, be sure to leave some sludge in the lagoon as "biological seed" to activate the treatment volume when the lagoon is refilled.

**Table 1: Biological treament alternatives. The anaerobic lagoon is the most commonly selected alternative for liquid waste.**

| Alternative | Features | Benefits | Drawbacks |
|---|---|---|---|
| Anaerobic lagoon | Earthen pond. 6 - 18 ft deep. Seepage control liner. Single or multiple cells. | Reduced solids volume. High nitrogen reduction. Moderate/good odor control. Can recycle effluent back to operation for flushing systems. | Requires high level of management. Sensitive to shock loading. Easily overloaded with organic matter. Additional clean water required to maintain treatment volume. Little treatment occurs in cold weather. |
| Passive aerobic lagoon. | Earthen pond. 3 - 5 ft deep. Seepage control liner. | Good/excellent odor control. | Requires larger surface area than anaerobic lagoon. Large water requirements to keep up with evaporative loss. Management requirements. Sensitive to shock loading. Little treatment occurs in cold weather. |
| Mechanically aerated lagoon | Earthen pond. 6 - 15 ft deep. Seepage control liner. Mechanical aeration equipment. | Excellent odor control. Same size or smaller than anaerobic lagoon. | High initial operating and maintenance costs for aeration. |
| Constructed wetland | Shallow diked area. 12 - 18 in | High solids removal. Appealing appearance. | Usually requires some pretreatment of waste. Need |

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|---|---|---|---|
| | deep. Seepage control liner. Dense growth of wetland plants. | Moderate/good odor control. Low maintenance, management requirements. | additional pond for storing waste until land-applied. Mosquito habitat. |
| Anaerobic digestor | Covered earthen pond or tank for reactor. | High solids reduction. Excellent odor control with cover. Biogas recovered for energy production. | High maintenance and management required. Need large operation to be cost effective. |

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